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Performance of Cellulose Acetate Membrane for Water Treatment in Riau Coastal Region

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Abstract: ***membrane technology is growing rapidly today, including in the field of water treatment coastal. The objective of this research is to preparred cellulose acetate membrane for coastal region in Riau, Sumatra, Indonesia. The perfomance cellulose acetate membrane to investigated perfomance cellulose acetate membrane for coastal region water treatment. The main objective of this study was make of cellulose acetate membranes for water treatment process to drinking water, determine the effect of operation pressure of the cellulose acetate membrane flux and determine the effect of rejection cellulose acetate membrane for color, hardness, turbidity and chloride parameters. Membranes prepared by phase inversion method with variation of cellulose acetate composition and operation pressure of 2-8 bars. Membrane characterization consists of calculation of membrane flux and rejection with coastal water as a feed. The research concluded that cellulose acetate membrane can be made by phase inversion method. Based on the research results cellulose acetate membranes can treat water at the coast of Riau, Sumatra, Indonesia. The influence of the operating pressure of the flux is higher the pressure, the higher flux generated. Cellulose acetate membranes are capable of removing components on coastal water such as turbidity, color, hardness and chlorides***

Keywords: cellulose acetate, coastal Riau, flux, membrane, rejection

1. Introduction

Water is the necessary resource for human survival, is indispensable in daily life [1]. According to researches, is severe shortage of water resource in Indonesia will reach 60 billion cubic meters by 2030 [2]. Coastal water is extensive in Riau, especially in the coastal Riau. High salt concentration and high fluorine content limit the uses of water resources. Coastal Water has obvious peculiar smell and taste, which can cause cancer, calculus, cirrhosis and other diseases [4]. High salinity in Coastal water, especially the sulfate and organic humic acid, is the main reason for these diseases. Coastal water with the degree of mineralization of more than 1000 mg/L, TDS with ranges 1500 – 6000 mg/L, turbidity than 14,8 mg/L, color than 98 mg/L, hardness than 500 mg/L, chloride than 1500 mg/L, pH with ranges 7-9 .

In recent years, Coastal water desalination has always been the research focus. Both the conventional process as distillation and emerging electrodialysis method can desalt Coastal water, however, they both have difficulties to overcome shortcomings. Because of its advantage, better output water quality and excellent cost performance, membrane technology has been widely adopted.

Membrane technology has advantages such as faster processes, low energy consumption, operation at mild temperatures, the non-addition of chemical products [10].

CA membranes were prepared via phase inversion. Phase inversion is one of the most substantial techniques for synthesizing porous polymer membrane [14]. Selection of this method because with this method produced the structure and morphology of the membrane is dense, compact and porous [10]. This method is also suitable for use in the manufacture of various polymeric membranes [14]. In this study used cellulose acetate as the main raw material of the membrane, acetone as the solvent and formamide as additives [3]. Cellulose acetate suitable as membrane materials because is an environmental friendly substance. Cellulose acetate can be found from acetylation process of cellulose [13].

2. Materials and Method

Membrane solutions consist of CA dissolved in a mixture of solvents/non-solvents and additive. The polymer content 17wt%, acetone content 56% and formamide 27% [9].

CA membranes were prepared via phase inversion. A 250 µm thick film of the membrane solution impregnated with acetone, by using a custom-build blade knife and an automatic film coater permitting the simultaneous casting.

Solutions at a 100 rpm casting speed. After a certain evaporation time, the nascent films were immersed in a coagulation bath (distilled water at 4°C) to induce the polymer precipitation and were kept there for 20 min. Afterwards a thermal annealing treatment followed, by immersing the membranes during a certain fixed time in a water bath at constant temperature 70°C). The membranes were stored in distilled water at room temperature until use. [10].

Membrane performance was evaluated in dead-end filtration experiments of feed solutions of coastal water. The feed solution was constantly stirred at 100 rpm to minimize concentration polarization and fouling [12].

The experiments were carried out at room temperature and at constant pressure (1,2, 3, 4 or 5 bars), provided by N_2. Permeates were collected as a function of time in closed glass vials, weighed and analyzed. The fraction collected during the first 15 minutes was discarded. All experiments were carried out in duplicate. In case that the variability of the measurements was higher than a 10% relative standard deviation a third replicate was done.

3. Results and Discussion

Effect of Operation Pressure Membrane on Flux

The membrane permeation flux is defined as the volume flowing through the membrane per unit area per unit time according to the following equations [6] :

$$J = \frac{V}{Axt} \quad (1)$$

Where J is Fluxs (L/m^2.hour), V is permeat volume (ml), A is membrane surface area (m^2) and t is time (hour). In this experiment examined the effect of operation pressure of the cellulose acetate membrane flux. The operation time were used that in the 2-8 bars.

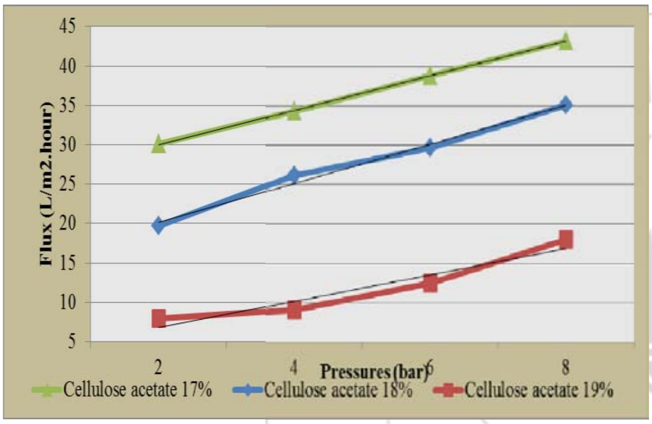

Figure 1: Curve effect of Operation Pressure on Flux

Based on the graph in Figure 1 can be seen that an increase in the flux of a pressure of 2 bar to 8 bar. The greater the operating pressure, the greater the resulting flux. The increase in the flux caused by the thrust (driving force) in the form of pressure on filtering process. Driving force given resulted in pressure on coastal water molecules so that the volume of coastal water that passes through the membrane per unit area per unit time increases.

Elimination of Coastal Water Components

Elimination of component on coastal water depends on the interaction of the membrane with the solute particles, membrane pore size and particle size that will pass through the pores of the membrane [7]. In this study, membrane allowance is reviewed through its ability in allowance for color, turbidity, hardness and chloride are shown in Figure 2 below.

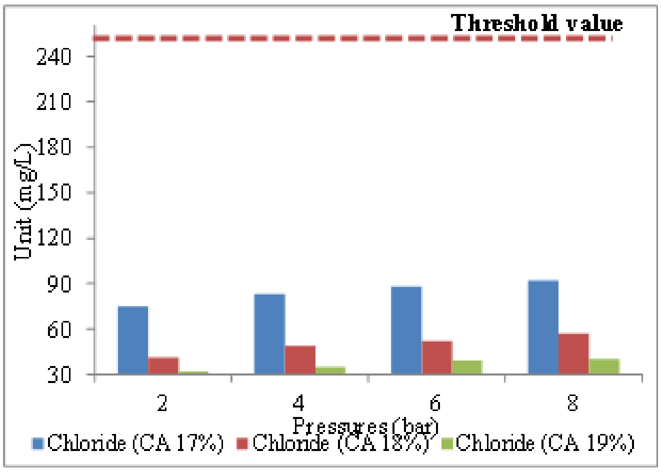

Figure 2 : Elimination of Chloride Component

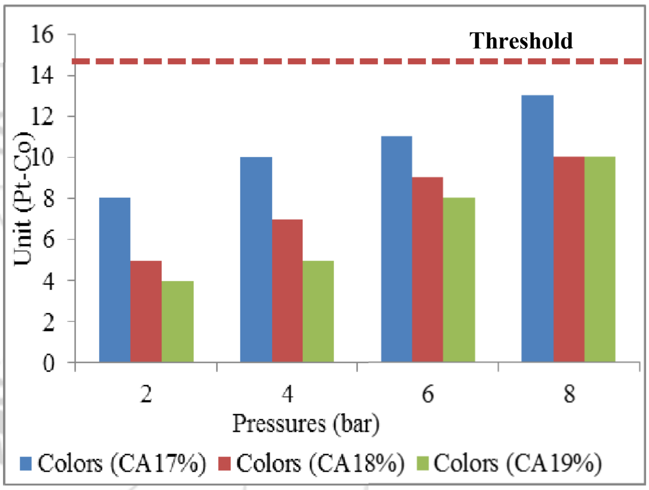

Figure 3 : Elimination of Colors Component

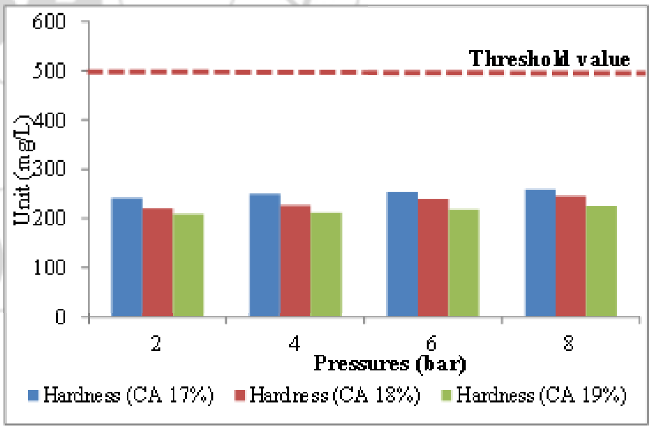

Figure 4 : Elimination of Hardness Component

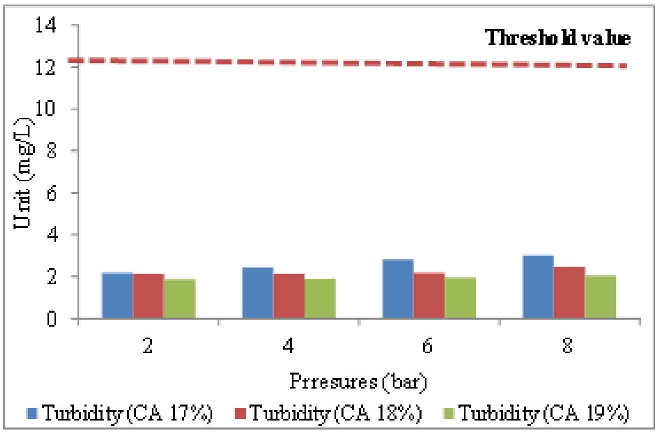

Figure 5 : Elimination of Turbidity Component

Based on the research results that cellulose acetate membranes are capable of removing impurity components in the coastal water. It can be seen in Fig. Organic and inorganic materials contained in water is often insoluble in water and will cause color changes in the water [8]. Air under normal circumstances and the net will not be colored, so it looks clear and crisp. Waste material or industrial waste also can cause color changes in the water. Prior to processing using the membrane, the color parameter in coastal water that is 144 PtCo, the value far exceeds the quality standards. By using cellulose acetate membrane, then a decline in color according to changes in the operating pressure. The decline in this color below the quality standard of clean water colors. That way, the cellulose acetate membranes can be used to lower the colors to match the quality standards set by Environmental Health Laboratory Unit Riau province [5].

Colloid causes the water to become cloudy which is aesthetically unattractive and can be detrimental to health. Turbidity can be caused by particles of clay, loam or from household waste and industrial waste or even because of their large number of microorganisms [11]. Decreasing the concentration of turbidity chart shown in Figure 14. The concentration of the water turbidity of coastal amounted to 12.473 NTU, after the coastal water is passed on cellulose acetate membranes then decrease the concentration of turbidity very sharply as the pressure changes. The decrease is due to colloidal particles or suspended cannot pass through cellulose acetate membrane (membrane pore size is smaller than the size of the particles in the coastal water), so that the resulting water becomes clear. Decrease in turbidity is far below the quality standard of drinking water is 5 NTU. In other words, the cellulose acetate membranes can be used to lower the concentration of water turbidity on the coastal water.

Hardness is caused by the presence of metals or monovalent cations 2, such as Fe, Sr, Mn, Ca, and Mg, but the main cause of hardness are calcium (Ca) and magnesium (Mg). The calcium in the water has the possibility of combining with bicarbonate, sulfate, chloride and nitrate, while the magnesium contained in the water the possibility of combining with bicarbonate, sulphate and chloride. In this study, decreased hardness components. The initial concentration of hardness is 780 mg/ L. With the processing of membrane technology then decrease the concentration of hardness as the pressure changes. The same thing happened in the allowance for chloride concentration, chloride concentration decreased with increasing operating pressure.

4. Conclusions

1) Cellulose acetate membranes can treat water at the coast of Riau, Sumatra, Indonesia.
2) The influence of the operating pressure of the flux is higher the pressure, the higher flux generated.
3) Cellulose acetate membranes are capable of removing components on coastal water such as turbidity, color, hardness and chlorides.

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Author Profile

Jhon Armedi Pinem received Bachelor's Chemical Engineering degree from the University of North Sumatera, Medan, Indonesia in 1997 susequently obtained a master's in from Chemical Engineering Institute Technology, Bandung (ITB) in 2001 and now Doctor candidate in Enviromental Science University of Riau. He is a lecturer in Chemical Engineering at Riau University and now head of Separation and Purification Laboratorium of Chemical Engineering University of Riau. His research field covers membrane technology, water and wastewater.